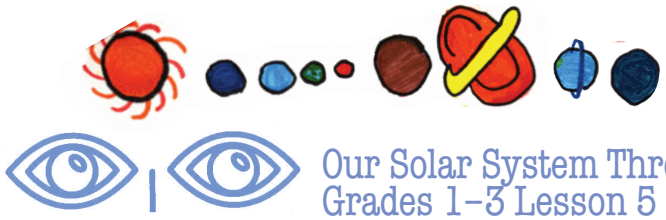


Our Solar System Through the Eyes of Scientists
Grades 1–3 Lesson 5 (Activities 1–5)

LESSON
# 5 Volcanoes — They're Everywhere!
## Activity 1 — Pre-Assessment

Activity Time
45 minutes

## Picture This!

### Introduction for Teachers

Do you ever wonder about volcanoes? How do they form? What are they made of? A volcano is a mountain that opens downward to a pool of molten rock below the surface of Earth. When pressure builds up, eruptions occur. Gases and rock shoot up through the opening and spill over or fill the air with lava fragments. Eruptions can cause lateral blasts, lava flows, hot ash flows, mudslides, avalanches, falling ash and floods. An erupting volcano can trigger tsunamis, flashfloods and earthquakes. Knowing how dangerous and exciting volcanoes can be, can you imagine being near enough to these fire-breathing mountains and posing for a picture? Meet Dr. Rosaly Lopes, Volcanologist (a special type of scientist) and Fearless Traveler, who loves to be near erupting volcanoes. She studies them here on Earth and also in other places in the solar system. Learn about Dr. Lopes and how she studies images of volcanoes to learn more about them. Your students will learn to think like real scientists, as they investigate mysterious volcanic rocks, analyze images of real volcanoes, and even create a model of what a volcano might look like. Your students will learn to think like scientists, using notebooks to observe and record and draw and ask new questions about what they see.

### Come In!

What do you think about volcanoes? Do you think there are other places in the solar system with active volcanoes? Yes! Volcanoes exist in several places in our solar system.

### Intended Curriculum

#### Big Idea

Learning about volcanoes on Earth and in the solar system through the eyes of Scientist–Fearless Traveler, Dr. Rosaly Lopes.

#### Science Objectives

Students will:

- Learn about volcanoes as seen through the eyes of scientist Dr. Rosaly Lopes.
- Investigate images of real volcanoes to compare and contrast.
- Discover that volcanoes exist on Earth and in other places in the solar system.

### Language Arts Objectives

Students will:

- Collect, record and sort images, providing accurate and detailed descriptions of different volcanoes.
- Synthesize their scientific findings in writing.
- Communicate with their peers to share knowledge of volcanoes.

## Materials and Teacher Preparation

### Materials

- "Meet the Scientist" segment below
- Colored pencils or crayons
- Pencils
- Science Notebooks
- Solar System Folder for each student
- Science Word Wall Chart
- "What Scientists Do" chart
- Photographs of volcanoes found on Earth and elsewhere in the solar system — one set for each student. These can be found in the Resource Materials section at the end of this activity.

### Teacher Preparation

- Distribute a Science Notebook and Solar System Folder to each student.
- Hang Science Word Wall Chart and "What Scientists Do" chart on board,
- Create evaluation rubrics (see teacher pre-assessment evaluation guidelines).

## Meet the Scientist

### The Story Begins! Meet Dr. Rosaly Lopes

Meet Dr. Rosaly Lopes. A scientist and fearless traveler, she studies volcanoes here on Earth and in other places in the solar system. She uses spacecraft to travel to other planets to get information about these fire-breathing mountains. Dr. Lopes grew up in Brazil. One day when she was watching television, she saw a woman working on the Apollo spacecraft that sent the first astronauts to the Moon. Dr. Lopes decided right then to become an astronomer for NASA. Then, years later, she saw her first volcano erupt, and that changed her mind forever.

"I was on Mount Etna in Sicily in July 1979 when the volcano started erupting. The active crater had a beautiful fire fountain spurting red lava about 30 to 50 feet up. It was the most beautiful spectacle, and I was hooked on volcanoes from then on."

Dr. Lopes left Brazil at the age of 18 to study astronomy at the University of London. She studied planetary geology and volcanology — the science of volcanoes. Dr. Lopes also studied about volcanoes on other planets, and, using information and images sent down to Earth from spacecraft that had visited Mars, she compared volcanoes there with those here on Earth. Being a fearless traveler as well as a scientist, Dr. Lopes is

an expert on the hazards from lava flows. She traveled to Italy and Hawaii to view erupting volcanoes, some of the time as a member of the UK Volcanic Eruption Surveillance Team. Now, Lopes works as a planetary scientist and volcanologist at NASA's Jet Propulsion Laboratory, where she studies volcanoes on Io, one of Jupiter's moons. She keeps discovering new volcanoes there!

Dr. Lopes wrote a book called "The Volcano Adventure Guide," which tells people how to visit and explore and take pictures of active volcanoes all over the world. Would you like to visit an active volcano?

Dr. Lopes says the most important thing she uses to record information about the volcanoes she studies is her science notebook. As she carries out experiments, she writes down everything she sees, even if she is standing next to a fire-breathing volcano! She says notebooks are most important because computers are too heavy to carry around the dangerous places she travels to in order to study volcanoes. "Volcanoes have shaped the Earth's surface and are nature's most powerful forces on our planet, and possibly in the solar system," she says.

## Discussion Prompt

- What do you think about volcanoes?
- What do you think about Dr. Lopes' decision to study volcanoes?
- Would you like to study volcanoes in the future? Why?
- What do you think causes volcanoes?

## Science Notebooks

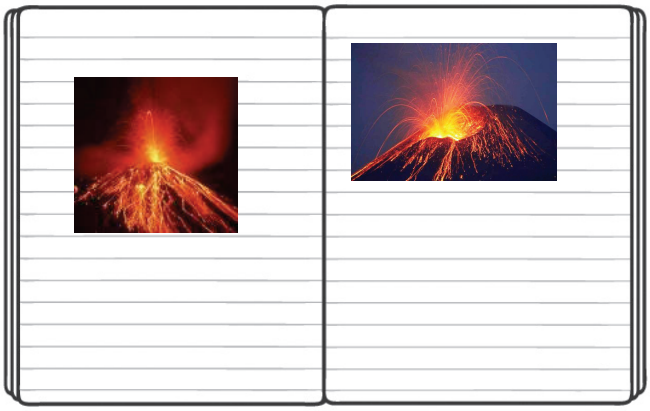
### Let's Begin Our Notebook Activity

Science notebooks are important to being a good scientist, because they help you remember what you see and observe, and what you want to know. As you learn new things, you can add them to your notebook.

### For Teachers

Print and pass out the photographs of four volcanoes to each student. (They are found at the end of this activity). Direct students to write what they see in the photographs. What does each volcano look like? Are they the same? Are they different? Think like scientists and write down everything you see!

Include drawings and illustrations.



**Science Word Wall**

These are words placed on a blackboard or other wall to get the students to start thinking about these concepts. As they learn more about the solar system, encourage students to add their own.

**First Words for the Science Word Wall**

volcano, lava, flow, eruption, landform, vent

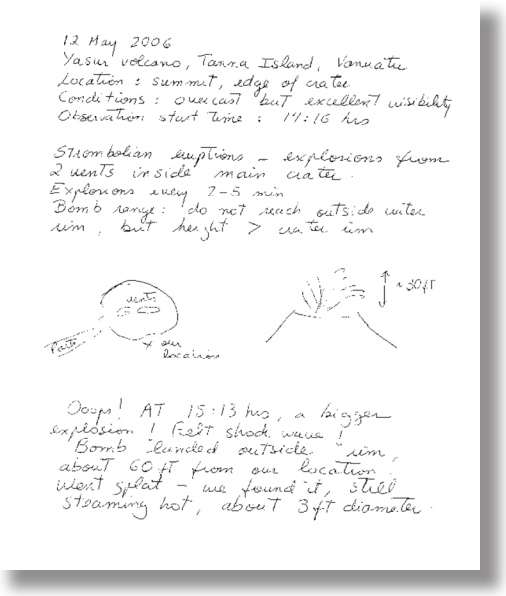
## Making Meaning

What have you learned?

Using the notebooks, ask students to share their words, pictures, ideas, phrases and sentences about volcanoes and what they think they know about them here on Earth and in other places in the solar system.

- Have students label what they draw in their notebooks.
- What do you think Dr. Lopes might have put in her notebook while she was studying pictures of volcanoes? What do you think she might write as she receives information from images sent by spacecraft about remote volcanoes?

Refer to the "What Scientists Do" chart: How did this activity help your students think and be like scientists? Compare and contrast the chart with student observations, recording, notebook and discussion activities.




Here is a page from Dr. Lopes' notebook, 2006.

## Teacher Pre-Assessment Evaluation

Objectives taught in this lesson may be used to create rubrics for evaluating student writing in notebooks and represent the pre-assessment for this unit.

- Volcanoes are found on Earth and on other planets.
- Volcanoes can be formed by magma, heated material (sulfur), or heated water.
- Volcanoes are areas where heated material from the interior of a body rises to the surface. Different explanations exist about how they are formed.

- Magma is the molten material beneath Earth's crust, and lava is the molten rock that comes out of a volcano or from a fissure in Earth's surface.
- A fissure is a crack.
- Molten rock comes from the underground magma. Lava is magma that has broken through the Earth's surface.
- Rocks form when the heated material from magma cools on the surface.
- Cryovolcanoes are cold volcanoes found on distant moons in the solar system.
- Provide written feedback about the notebook elements required by this lesson.

### Standards

**National Science Standards**

- Physical Science: Landforms on Earth and other places in the solar system
- Physical Science: States of Matter
- Earth and Space Science: Objects in the sky

**National Council of Teachers of English (NCTE) Standards for the English Language Arts**

- Students read a wide range of print and nonprint text to build an understanding of nonfiction texts and to acquire new information.
- Students apply a wide range of strategies to comprehend, interpret, evaluate and appreciate texts.
- Students adjust their use of spoken, written and visual language to communicate effectively with a variety of audiences and for different purposes.
- Students employ a wide range of strategies as they write and communicate with different audiences for a variety of purposes.
- Students conduct research by generating ideas and questions, and by posing problems. They gather, evaluate and synthesize data to communicate their discoveries.
- Students use spoken, written and visual language to accomplish their own purposes for learning, enjoyment, persuasion and the exchange of information.


### Acknowledgments

Dr. Rosaly Lopes, Planetary Scientist, NASA's Jet Propulsion Laboratory

Exploratorium Institute for Inquiry – Marilyn Austin

Bob Tierney and John Dorroh, *How to . . . Write to Learn Science*, Second Edition, NSTA press.

## Further Exploration

To learn more, please visit these websites:

GOES Project Volcano Watch —
*http://goes.gsfc.nasa.gov/text/goes.volcanoes.html*

Information on current volcanoes —
*http://earthobservatory.nasa.gov/NaturalHazards/category.php?cat_id=12*

"How Volcanoes Work" —
*http://www.geology.sdsu.edu/how_volcanoes_work/*
(See "Volcanism on Other Worlds" and "Planetary Volcanism" on this website)

Volcanoes on Mars at NASA's Mars Exploration Program —
*http://marsprogram.jpl.nasa.gov/gallery/volcanoes/*

Io's alien volcanoes —
*http://science.nasa.gov/science-news/science-at-nasa/1999/ast04oct99_1/*

Volcano images (1 of 4)

1 per student


Aerial view of Mount St. Helens as seen from the southeast. USGS photograph taken on February 3, 2005, by Matt Logan.

Volcano images (2 of 4)

1 per student

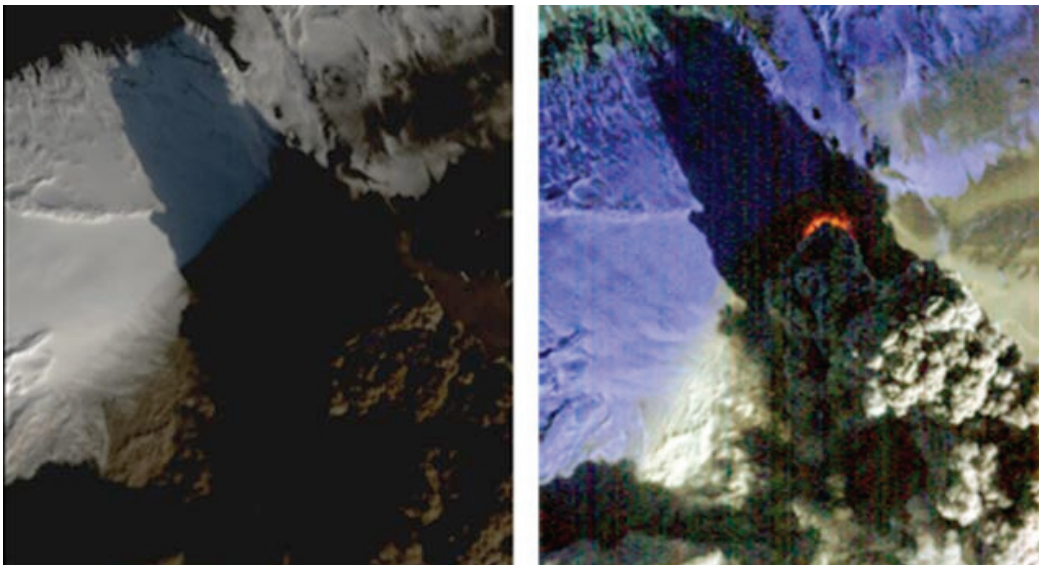
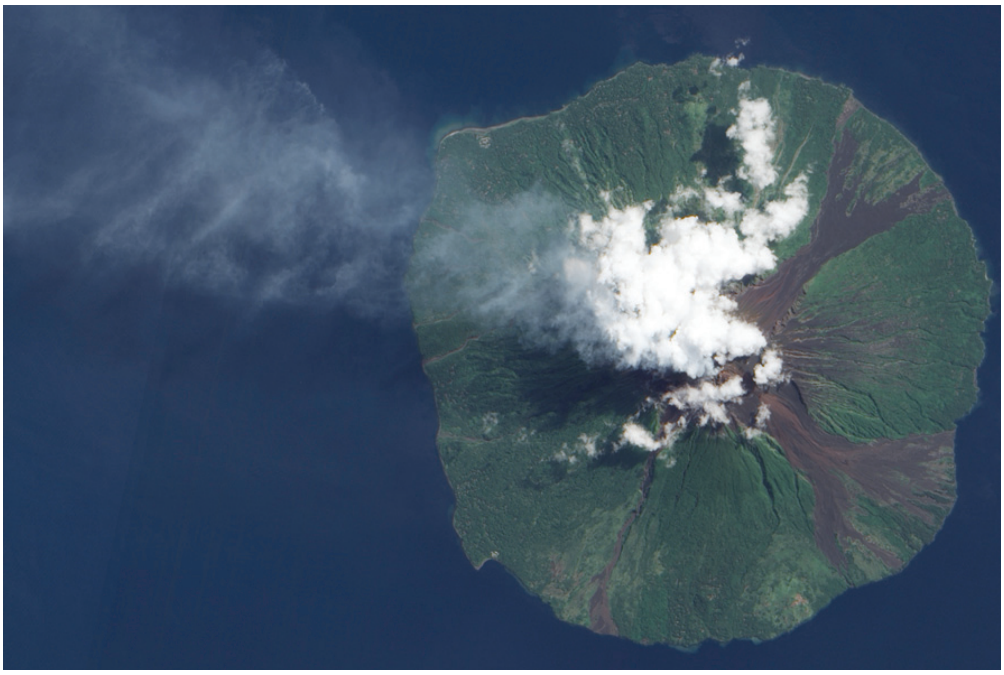


Image credit: NASA/JPL/EO-1 Mission/GSFC/ Ashley Davies.

Visible (left) and infrared (right) images of Iceland's Eyjafjallajökull volcano, acquired April 17, 2010, from the Hyperion instrument onboard NASA's Earth Observing-1 (EO-1) spacecraft.

Volcano images (3 of 4)

1 per student

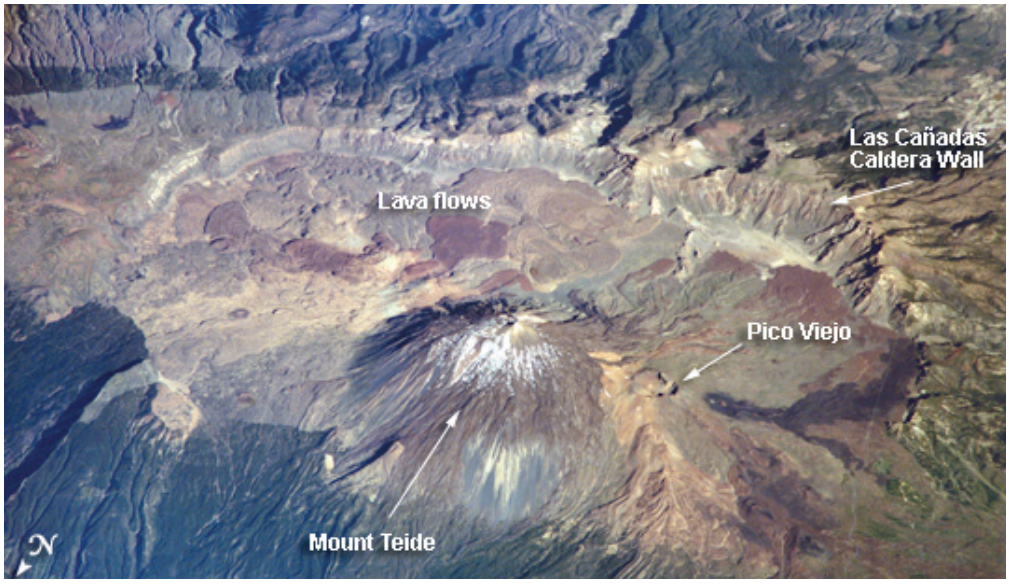


NASA image created by Jesse Allen, using EO-1 ALI data provided courtesy of the NASA EO-1 Team.

NASA satellite image of Kilauea volcano in Hawaii taken in late May 2009, showing plumes from the vent and searing lava reaching the ocean water.

Volcano images (4 of 4)

1 per student




Tenerife Island, Spain, is featured in this volcano image photographed by an Expedition 13 crewmember on the International Space Station. Tenerife is the largest of the Canary Islands, a Spanish possession located off the northwestern coast of Africa.

LESSON 5

# Volcanoes — They're Everywhere!

## Activity 2 — Try This!

Activity Time
45 minutes

## Rock On!

Rocks come in all shapes, sizes, and colors. In this activity, your students will think like real scientists and investigate a mysterious rock from a volcano — the very same rocks that Dr. Lopes studies. Your students will observe and record characteristics of the rock, and record observations and data in their notebooks.

### Intended Curriculum

#### Big Idea

Learning about volcanoes on Earth and in the solar system through the eyes of Scientist–Fearless Traveler, Dr. Rosaly Lopes.

### Science Objectives

Students will--

- Learn about volcanoes as seen through the eyes of Scientist–Fearless Traveler, Dr. Rosaly Lopes.
- Investigate images of rocks and learn about physical properties of rocks.
- Discover that volcanoes exist on Earth and other places in the solar system

### Language Arts Objectives

Students will:

- Use "Content Blasts" to further understanding by reading and writing.
- Synthesize their scientific observations and findings in writing.
- Communicate with their peers to share knowledge of volcanoes.

### Materials and Teacher Preparation

#### Materials

- Colored pencils or crayons
- Science Notebooks
- Science Word Wall Chart
- "What Scientists Do" chart
- Volcanic rock pumice for each group of students
- Small magnifying glasses (two per group)
- Glue
- "Content Blasts 1, 2, 3 and 4" (see the Resource Materials section at the end of this activity)

#### Teacher Tip

Volcanic rock pumice is found at any hardware store or in the garden departments of most large home improvement stores.

## Lesson Procedure

- Divide the students up into groups of four.
- Distribute one volcanic pumice rock to each group of students.
- Direct students to imagine they were hiking and found this rock. What kind of rock is it? What does it look like? What does it feel like?
- Direct students to look through the magnifying glass. Then direct them to feel the rock. How heavy is it? Is it smooth? What do you think it is made from? Discoveries made about this rock are what scientists call the "properties" of the rock.
- Direct students to take out their science notebooks.

## Science Notebooks

### Let's Begin Our Notebook Activity

Notebooks are really important to being a good scientist, because they help you remember what you see, observe, feel and record.

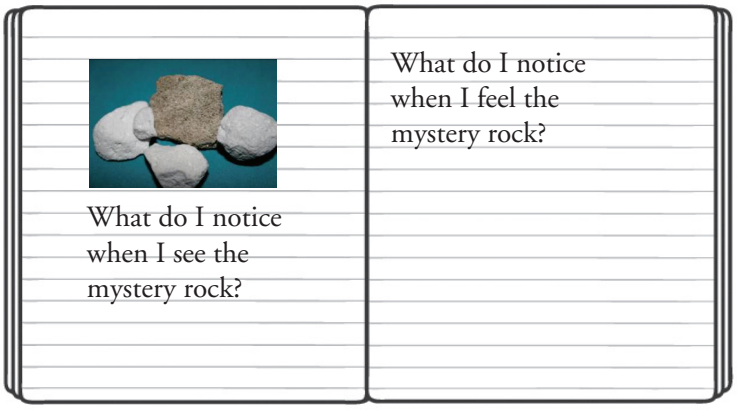
- What did you learn about this rock? What do you notice about this mystery rock?

### For Teachers

Direct students to write down three or more things that they see when they look at the rock. Then direct them to write down three or more things that they observed when they felt the rock.

Lead students in a group discussion. Ask them what they notice about the rock.

- What do your students wonder about the rock? What "properties" did they observe?
- Where do you think this rock came from? What does this rock remind you of? Where do you think this rock might be found in the solar system?




### Science Word Wall Additions

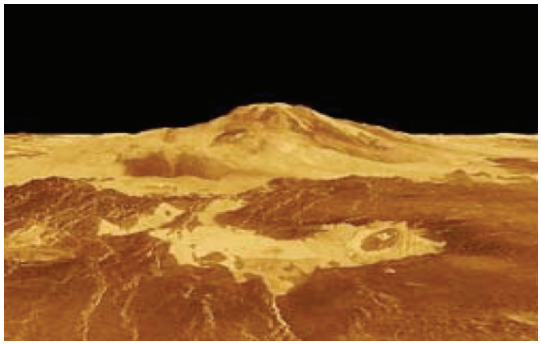
Physical property: What an object looks and feels like — Size? Weight? Color? Shiny? Dull? Smooth? Hard? Soft?

## Making Meaning

- Where did the rock come from? Direct students to write in their notebooks their "predictions" about where the rock might have come from. Then distribute Content Blasts 1–4 (see Resource Material).
- Discuss with the students that the rock is volcanic, then read the four Content Blasts to the class.
- Discuss the content about volcanoes, then lead discussion, asking if any of the students had changed their prediction about where the mystery rock had come from since learning it was from a volcano.
- Discuss terms on the Science Word Wall and their meanings.

Right: Volcano on Earth.

Far right: Volcano on Venus.



### Science Word Wall Additions

magma, lava, crater, vent, molten


## Acknowledgments

Dr. Rosaly Lopes, Planetary Scientist, NASA's Jet Propulsion Laboratory — *http://solarsystem.nasa.gov/people/profile.cfm?Code=LopesR*

Michael Klentschy and Laurie Thompson, *Scaffolding Science Inquiry Through Lesson Design*, Heinemann, 2008.

Marilyn Austin, Bob Tierney, and John Dorroh, *How to . . . Write to Learn Science*, Second Edition, NSTA press.

The Private Eye — Looking/ Thinking by Analogy


## For Further Exploration

The U.S. Geological Survey website has a glossary of volcanic terms with pictures. You may want to add these pictures and definitions to your Science Word Wall Chart — *http://volcanoes.usgs.gov/images/pglossary/index.php*

## Teacher Background

Refer to Reading Adventure Book, Lesson 5, Activity 4. Before you continue you may want to read the mini-book on Dr. Lopes and volcanoes before further investigations in this module. The USGS website that features volcanic terms also has other resources on volcanoes that may be helpful.

Dr. Rosaly Lopes has written a book on volcanoes found on Earth called *Volcanic Worlds, Exploring the Solar System's Volcanoes*, ISBN 3-540-00431-9.

Content Blast #1

## Erupting Volcanoes

An erupting volcano is an exciting thing to see. When the Earth's surface has a deep vent, molten rock may rise to the surface from far below the crust. Depending on the **pressure** involved and the **composition** of the rock, the eruption may be explosive or gentle. When the pressure is great, a volcano may explode, throwing material many miles from the eruption. When the composition of the rock has little water or silica, the eruption may flow in ribbons of lava down the mountain side without a violent explosion. A few volcanic eruptions have been known to knock down forests or cover whole towns.

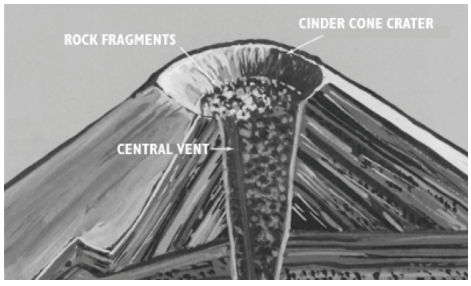
Volcanoes have several features that vary from volcano to volcano. The hole that goes down to the molten rock deep inside the Earth is called a **vent** or **pipe**. The top of the mountain usually has a dish-shaped hole which is called a **crater** located above the vent.

An erupting volcano.

Some volcanoes have lava domes rather than a crater or may even be a huge plateau like the Modoc Plateau in California. Every time a volcano erupts, it leaves a layer of ash and lava, which, over time, builds up the height of the mountain. Sometimes cracks happen in the sides of the mountains that let lava flow out. These cracks are called **side vents**. When a volcano becomes active, there is usually an ash cloud flowing out above the eruption. This cloud can climb very high and can even produce lightning. Dust from this cloud can settle down many miles away, covering everything in its path.

Volcanic molten rock can have different compositions. Rhyolites are not very fluid. This type of rock is composed of over 69% silica, making the rock very thick. The thickness traps gas and causes volcanoes to erupt violently. If the molten rock has 52 to 63% silica, like andesite, the volcano is not as explosive. With 45 to 52% silica, the lava flows down the mountain without erupting violently, like Mauna Loa on Hawaii.

Dr. Lopes says that scientists really are not sure just how volcanoes work. Just like people, each volcano is different and each one has a different story to tell.




Parts of a volcano.

Content Blast #2

## How Do Scientists Classify Volcanoes?

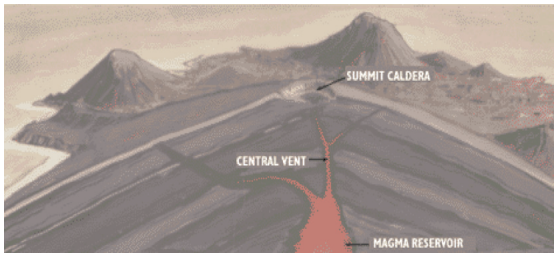
One way to classify volcanoes is by the shape of the mountain. **Shield volcanoes** like those in Hawaii build up slowly and look like a warrior's shield. These volcanoes have quiet eruptions that make gentle, sloping volcanoes.

**Cinder cones** come from volcanoes that throw out small cinder-shaped rocks that build up around the vent. These eruptions make small, cone-shaped mountains. A cinder-cone crater in Mexico called Paricutin volcano is an example.

**Stratovolcanoes** or **composite** volcanoes are tall, cone-shaped mountains that have many layers. One layer is a lava flow and another is made of ash. Eruptions of these volcanoes leave layers composed of different-sized material. Mt. Fuji in Japan is a stratovolcano.

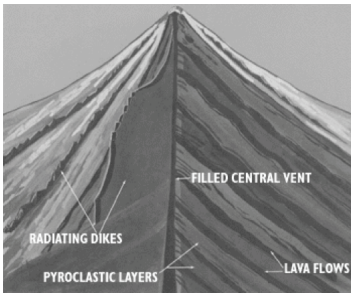
Another type of volcano is a **lava dome**. These are relatively small piles of lava that are too thick to flow any great distance, so instead of flowing, they pile up around the vent. As the lava pile grows, the outer layer cools, hardens, and then shatters, spilling pieces down the side of the dome. Katmai in Alaska is an example of a lava dome.

With all we know about volcanoes on Earth, there are still mysteries that we do not understand.

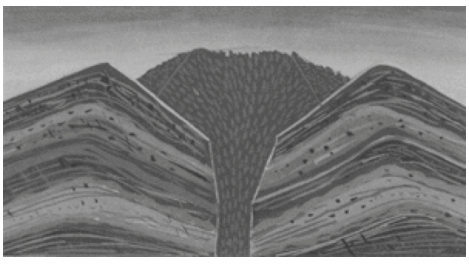



The internal structure of typical shield volcano.

A stratovolcano.




A lava dome.



Building a lava dome.

Content Blast #3

## Are Volcanoes Only Found on Earth?

We know about Earth volcanoes, but we do not completely understand them. Volcanoes are found not only on Earth but throughout our solar system.

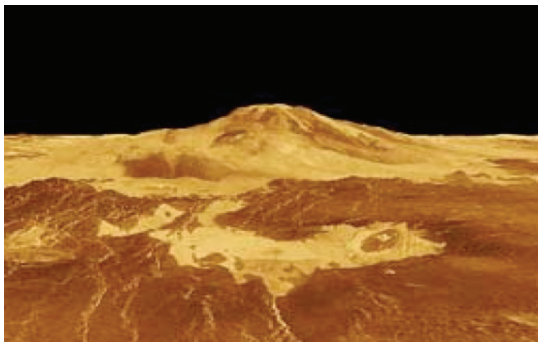
Scientists like Dr. Lopes have found volcanoes on other bodies in our solar system such as Earth's Moon, Venus, Mars, a moon of Jupiter called Io, and a moon of Saturn called Enceladus. There may even be volcanoes on other icy moons near the gas giant planets.

Our Moon's volcanoes occurred between 1 and 4 billion years ago and happened when the Moon was hit by a huge meteor. The impacts from the meteor allowed molten rock to flow out on the surface of the Moon.

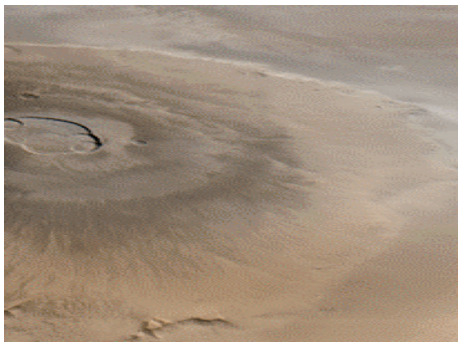
Venus has more volcanoes than any other planet in our solar system, totaling over 1,600 volcanoes. Venus does not seem to have cracks in its crust like Earth, so volcanoes are found only in certain areas. Venus's volcanoes may not have erupted with great force. This may be because there seems to be no water on Venus. Water seems to make volcanoes erupt violently. One reason water adds to the violence is because one cubic foot of water makes 1,700 cubic feet of steam. That is a lot of force to add to an eruption.

Mars has three volcanic areas. One of these areas has the biggest volcano ever found — a shield volcano called Olympus Mons that towers 17 miles above the Martian surface. Volcanoes on Mars do not seem to have erupted violently. Once again, this may be due to the lack of water.

Are the volcanoes on Mars and Venus active? Dr. Lopes says, "We don't have any real evidence that there are active volcanoes on Mars and Venus, but there have been suggestions that because of levels of particular gases in the atmosphere, there might be some activity. Nothing is proven, however. If there is any activity, it is very sporadic."



A volcano on Venus.



Olympus Mons on Mars.

Content Blast #4

## What's New?

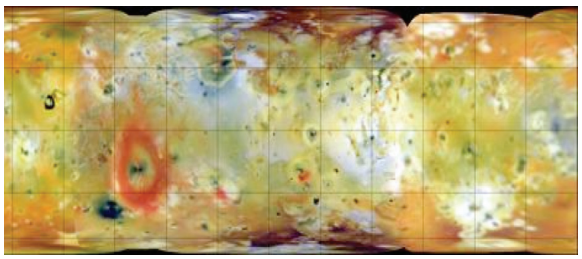
Io, a moon of Jupiter, has the largest number of active volcanoes in the whole solar system. When Dr. Lopes was studying this tiny moon of Jupiter, she found 71 erupting volcanoes. These volcanoes may be spewing sulfur and look like bubbling pools of lava.

Other icy moons may have volcanoes of water ice that are somewhat like Old Faithful in Yellowstone National Park. Scientists using the Cassini spacecraft have discovered icy geysers on Enceladus, a moon of Saturn. Many other moons around the gas giants may have geyser volcanoes. They are not exactly like Earth geysers because our water volcanoes are hot, and these outer solar system geysers spray out ice crystals.

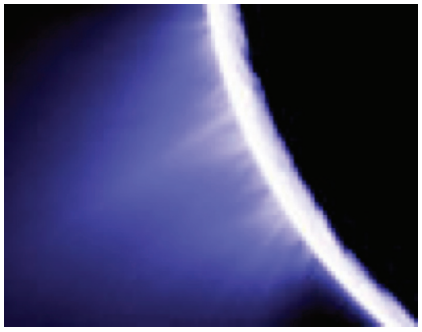
When Dr. Lopes was asked how volcanoes in our solar system compared to volcanoes on Earth, this is how she replied:

"There are many different types of volcanic eruptions on Earth, so you might watch a gentle lava flow moving slowly in somewhere like Hawaii or a very explosive eruption such as that of Mount St. Helens in 1980. If you could watch a volcano on Mars or Venus erupt, it would probably be similar to those in Hawaii, with long lava flows. On Io, you would most likely watch a lava lake bubbling away, like what has happened in Hawaii and also in places such as Erta Ale in Ethiopia. The geysers on Enceladus might look a bit like Yellowstone, except that you would not see a jet of water like at Old Faithful, because you would see particles of ice instead of liquid."

Our solar system has a large variety of volcanoes, and more surprises will come from future discoveries.



The volcanic surface of Io, a moon of Jupiter.



Ice geysers on Enceladus are cold.

Old Faithful geyser in Yellowstone National Park is hot.

LESSON 5

# Volcanoes — They're Everywhere!

## Activity 3 — Do This!

Activity Time
45 minutes

## Make a Volcano Model!

### Introduction for Teachers

Can you imagine being near a volcano that is erupting? What would it be like? Because of the extreme heat and dangerous plumes, it would not be safe for your students to experiment with a real volcano. Instead, let's blow our top with a baking soda and vinegar model of what a volcano might look like. Have your students collect their Science Notebooks, and let's investigate.

### Intended Curriculum

#### Big Idea

Learning about volcanoes on Earth and in the solar system through the eyes of Scientist–Fearless Traveler, Dr. Rosaly Lopes.

#### Science Objectives

Students will:

- Understand the basic characteristics of a volcanic eruption.
- Use inquiry to investigate a model of an eruption.
- Understand the difference between a model volcano and a real volcano.

#### Language Arts Objectives

Students will develop clarity of communication by:

- Recording in science notebooks; labeling drawings with appropriate vocabulary; producing descriptions; and writing "I predict" statements.
- Using science notebooks as a source for discussing ideas.

### Materials and Teacher Preparation

#### Materials

You will need:

- Colored pencils, crayons, markers
- Science Notebooks
- Small paper cups (2 cups per team of 2 or 3 students)
- 1 teaspoon baking soda (per team)
- Vinegar: 1 paper cup (per team)
- Paper towels (to place under paper cups)
- Film canisters (2 per team of students)
- Safety goggles (1 for each student)

## Lesson Procedure

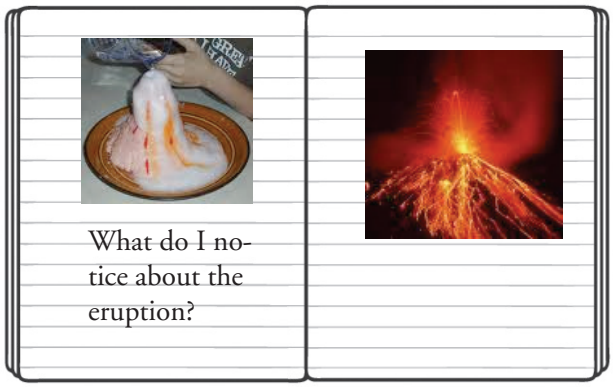
- Direct students to take out their notebooks so they will be able to record what they see, and ask them to try to avoid getting their notebooks wet during the experiment.
- Divide students into teams of two or three and pass out paper cups, baking soda and vinegar.
- Ask students to prepare their notebooks to ask the question "What do I notice about the eruption?"
- Put 1 tsp of baking soda in a film canister. Place on top of a paper towel.
- Pour vinegar into another canister until it almost fills the canister. Place on the table.
- Have students write a prediction in their notebooks about what will happen before they add the vinegar.
- Have one student in each group get ready to pour the liquid. Hold a countdown and then say "pour." Wait until the reactions are finished.
- Have the students record what they observed in their notebooks.

## Science Notebooks

### Let's Begin Our Notebook Activity

- Direct students to repeat the question: "What did I notice about the eruption?"
- Direct students to write descriptions of everything they saw. Include drawings and illustrations. Label notebooks.

What would Dr. Lopes include in her notebook as she looks at volcanoes both here on Earth and other places in the solar system?




## Science Word Wall Additions

Plume — an eruption cloud of gases, ash, and/or rock fragments rising from the vent of a volcano.
Eruption — an action in which solid material, liquid or gas is ejected onto the surface by volcanic activity.
Magma — molten material that is beneath the surface.
Flow — the path lava flow travels out of a volcanic vent.
Ejecta — material that is thrown out of a volcano.
Models — tools used by scientists to represent things that are too big, too small, too hot or too far away. Some parts of the model may be like the real thing, and some parts are not.

## Making Meaning

Have students refer to their Science Notebooks.

What have you learned?

Have students refer to the four images from Activity 1.

- What do real volcanoes look like?
- How do you think this model volcano is like a real volcano? How do you think it is different?
- Why do scientists use models? (Scientists cannot always work with the real thing. Real things might be too big, too small, too hot or too far away. Scientists spend a lot of time trying out different things with models. A lot of space in their notebooks is taken up with recording data from creating, manipulating and using models.)
- Where do you think this type of volcano (our model) might be found? The baking soda investigation is like a lot of the volcanoes on Earth.
- What do you think volcanoes on other worlds might be like?
- What are the major parts of a volcano? Would these parts be the same on every object in the solar system that has volcanoes?

Share with a partner or group what you have written in your notebooks.

As a class, what are your conclusions about volcanoes?


## Acknowledgments

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Michael Klentschy and Laurie Thompson, *Scaffolding Science Inquiry Through Lesson Design*, Heinemann, 2008.

Marilyn Austin, Bob Tierney, and John Dorroh, *How to...Write to Learn Science*, Second Edition, NSTA press.

Kerry Ruef, *The Private Eye—Looking/Thinking by Analogy*, 1992.


## Further Exploration

The U.S. Geology Survey website has a glossary of volcanic terms and pictures. You may want to add these pictures and definitions to your Science Word Wall.
***http://volcanoes.usgs.gov/images/pglossary/index.php***

The Arizona State University Mars Education Department offers several resources that can be used for further explorations (click on the "Resources" tab) —
***http://marsed.asu.edu/front***

## Teacher Background

Refer to Reading Adventure Book, Lesson 5, Activity 4. You may want to read the mini-book about Dr. Lopes and volcanoes before further investigations in this module. At the USGS website listed above, there are more resources on volcanoes that can be helpful.

## Teacher Resource Information

### Directed Discussion

Direct students in a discussion about what they learned from making the model of a volcano in the classroom

- I learned that volcanoes erupt. I know this because in our investigation there was stuff flowing out.
- Real volcanoes are bigger than our volcanoes. I know this because we could not have a real volcano in our classroom. We would be in big trouble if a volcano erupted. They are hot and dangerous.
- I wonder — Are all volcanoes on Earth the same? Are Earth volcanoes the same as other volcanoes in our solar system?

What do you wonder about this investigation and real volcanoes? Why do we use models in the classroom? Read the following to your class:

### Why Do We Use Models in the Classroom to Study Volcanoes?

Dr. Lopes's work can be dangerous. When we study volcanoes in the classroom, we use models so that students are not placed in danger.

Dr. Lopes said: "My favorite volcano is Mount Etna, because it was the first volcano I visited and studied. Etna taught me a lot, and I have a special fondness for it. It can be a treacherous mountain, so it made me aware of many of the dangers of active volcanoes."

Volcanoes on Earth are dangerous because:

- They are HOT. Different colors of lava represent different temperatures — orange to yellow is about 900 degrees Celsius (1,650 degrees Fahrenheit); dark to bright cherry red is 630 degrees Celsius (895 degrees Fahrenheit). To give you an idea of how hot that is, a pizza oven ranges from 260 to 315 degrees Celsius (500 to 600 degrees Fahrenheit).
- In an eruption, clouds of ash can cover plants, animals, buildings and people. Outside plants get covered with ash and die.
- Poisonous gases can kill people and animals.
- Buildings can be destroyed.
- In the last 500 years, at least 200,000 people have died due to volcanic eruptions.

This is why we use models inside the classroom. Scientists use other kinds of models such as computer models. When they can, scientists face the dangers and venture outside to experience a volcano first-hand. They prepare before visiting active volcanoes by wearing safety helmets and special protective clothing. They also have escape routes.

LESSON 5

# Volcanoes — They're Everywhere!

## Activity 4 — Read All About it!

Activity Time
45 minutes

## A Volcano Adventure

### Introduction for the Teacher

This reader is all about a journey to a volcano — A volcano adventure as seen through the eyes of Scientist–Fearless Traveler, Dr. Rosaly Lopes.

### Intended Curriculum

#### Big Idea

Learning about volcanoes on Earth and in the Solar System through the eyes of Scientist–Fearless Traveler, Dr. Rosaly Lopes.

#### Science Objectives

Students will:

- Learn about volcanoes as seen through the eyes of scientist Dr. Rosaly Lopes.
- Discover that volcanoes exist on Earth and other places in the solar system.

#### Language Arts Objectives

Students will—

- Read about and gain a thorough understanding of volcanoes on Earth and other places in the solar system.
- Synthesize their scientific findings in writing.
- Communicate with their peers to share knowledge of volcanoes.

### Materials and Teacher Preparation

#### Materials

- A copy of "A Volcano Adventure Through the Eyes of Scientist and Fearless Traveler, Dr. Rosaly Lopes" for each student.
- Science Notebooks
- Solar System Folder for each student
- Science Word Wall Chart

#### Teacher Preparation

- Make copies of the "A Volcano Adventure Through the Eyes of Scientist and Fearless Traveler, Dr. Rosaly Lopes" reader for each student.
- Have other materials ready.

### Lesson Procedure

- Distribute a reader to each student and read it aloud.
- Explain key terms like magma, lava and vent, and how Dr. Lopes might define these terms.

A Volcano Adventure reader (3 pages)

1 per student

# A Volcano Adventure

This is the story of a volcano adventure as seen through the eyes of Scientist-Fearless Traveler, Dr. Rosaly Lopes.

I'm on a volcano adventure in Hawaii with scientist Rosaly Lopes. We climb up a mountain together to look down into the crater of a volcano. As we are climbing, we notice that there are no trees on the sides of the mountain. The volcano must have erupted too recently for trees to have had time to grow.

When we get to the top, we look down into the crater of the volcano. The inside of the volcano is very hot. It smells really bad, like rotten eggs. I can see glowing hot magma inside the volcano. It's hard to imagine that the magma I see is molten rock that came from beneath the surface of the Earth. I make some notes in my notebook about what I see, and I draw pictures of the volcano and of the magma.

Rosaly uses her science notebook, too. She draws the shape of the volcano, and makes notes about its size.

**Dr. Lopes and an erupting volcano, Mt. Yasur, Vanuatu.**

**Anatahan Volcano, one of the Ring of Fire volcanoes.**

She lowers a thermometer into the crater of the volcano and writes down how hot it is. I had never seen anybody take a volcano's temperature before.

I've been preparing for this journey for a long time. I learned about volcanoes in school, and I read books about volcanoes, so now I know a lot about them. I know that the word "volcano" comes from Vulcan, the Roman god of fire. I learned that more than 80 percent of the Earth's surface is volcanic in origin. I read that the ocean floor and some mountains were formed by countless volcanic eruptions. Rosaly told me that gaseous emissions from volcanoes formed the Earth's atmosphere millions of years ago.

Did you know that there are more than 500 active volcanoes on Earth? More than half of these volcanoes are part of the Ring of Fire, a region that encircles the Pacific Ocean along the Earth's tectonic plates.

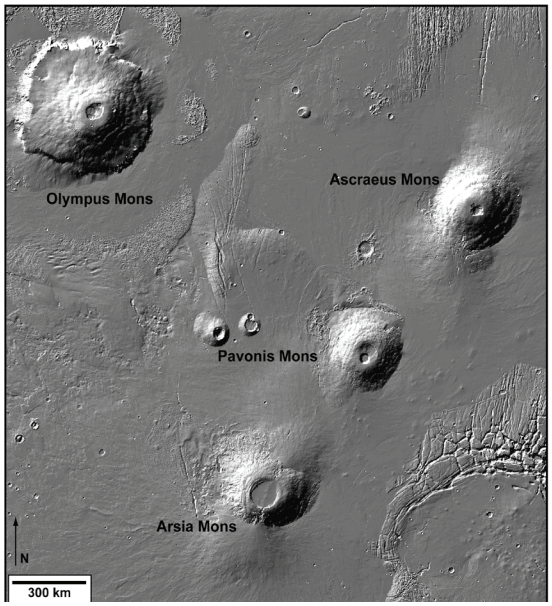
"Make sure you're wearing your hard hat," Rosaly reminds me. "Sometimes volcanoes can surprise you and erupt when you don't expect it. This volcano looks like it's ready to blow!"

Just then, I heard a low rumbling sound. I felt the ground beneath me start to shake. Rosaly and I knew what this meant: the pressure had built up inside the volcano, and it could erupt at any moment.

**A lava fountain.**

Even though Rosaly and I love adventures, we know it's not safe to stand so close to an active volcano. If the volcano erupted, the cloud of gas and dust that wouild fill the air wouldn't be safe for us to breathe. The lava that flows down the side of a volcano when it erupts is so hot that it can start fires. We climb back down the mountain to safety before the volcano has a chance to erupt.

As we climb back down the mountain, Rosaly tells me about other kinds of volcanoes. As much as she likes the volcanoes she can study on Earth, what really excites her are the volcanoes on other planets and moons in our solar system. Rosaly tells me that Mars used to have active volcanoes. The biggest volcano in our solar system is Olympus Mons on Mars. It is 15.5 miles (25 kilometers) tall, and it stretches over nearly 340 miles (550 kilometers) across from east to west.




**Olympus Mons and companion volcanoes on Mars.**

Rosaly says that Venus has volcanoes, too. Planetary scientists have identified more than 1,600 major volcanoes or volcanic features on Venus. Scientists don't know if Venus is volcanically active today. Jupiter's moon Io has over 400 active volcanoes. Io is the most volcanically active moon in our solar system. The Voyager spacecraft first observed volcanic eruptions on Io in 1979. Rosaly has been fascinated by volcanoes ever since.


**Tvashtar volcano on Jupiter's moon Io.**

I hope I'll get to go on another volcano adventure with Rosaly Lopes someday. What would you hope to discover on your own volcano adventure?

## Acknowledgments

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Bob Tierney and John Dorroh, *How to... Write to Learn Science*, Second Edition, NSTA press.

Kerry Ruef, *The Private Eye—Looking/Thinking by Analogy*, 1992.

## Further Exploration

To learn more, please visit these websites —

"How Volcanoes Work" —
*http://www.geology.sdsu.edu/how_volcanoes_work/*

GOES Project Volcano Watch —
*http://goes.gsfc.nasa.gov/text/goes.volcanoes.html*

More volcano websites —

*http://earthobservatory.nasa.gov/NaturalHazards/category.php?cat_id=12*

*http://www.fema.gov/kids/volfacts.htm*

*http://science.nasa.gov/science-news/science-at-nasa/1999/ast04oct99_1/*

*http://www.jpl.nasa.gov/news/news.cfm?release=2010-121*

*http://eosweb.larc.nasa.gov/EDDOCS/Aerosols/Volcano_Types_Lesson.html*

*http://nasa.ibiblio.org/details.php?videoid=6204&start=0&subject=Science*

*http://core2.gsfc.nasa.gov/research/volc2/volc_top.html*

LESSON 5

# Volcanoes — They're Everywhere!

## Activity 5 — Amazing Moons

Activity Time
45 minutes

## Awesome Erupting Volcanoes

### Introduction for Teachers

What have your students learned about volcanoes, both here on Earth and in other places in the solar system? Help your students write a compare and contrast essay. What is the most amazing thing your students have learned about volcanoes? Students can use their science notebooks to write about what they now understand about volcanoes. Using concepts such as how volcanoes form, what they are made out of and using key terms like magma and lava, they can describe volcanic eruptions based on their own observations and thinking about the different activities from this lesson.

### Intended Curriculum

#### Big Idea

Learning about volcanoes on Earth and in the solar system through the eyes of Scientist–Fearless Traveler, Dr. Rosaly Lopes.

#### Science Objectives

Students will:

- Learn about volcanoes as seen through the eyes of Scientist–Fearless Traveler, Dr. Rosaly Lopes.
- Investigate images of real volcanoes to compare and contrast.
- Discover that volcanoes exist on Earth and other places in the solar system.

#### Language Arts Objectives

Students will:

- Read and understand information.
- Reflect on and recognize their own learning through notebooks.
- Use accurate language to communicate their scientific understanding orally and in writing.

### Materials and Teacher Preparation

#### Materials

- A copy of "A Volcano Adventure Seen Through the Eyes of Scientist and Fearless Traveler, Dr. Rosaly Lopes" reader for each student
- Science Notebooks
- Solar System Folder for each student
- Science Word Wall Chart

#### Teacher Preparation

- Make a copy of the "A Volcano Adventure Seen Through the Eyes of Scientist and Fearless Traveler, Dr. Rosaly Lopes" reader for each student.

## Lesson Procedure

- Hand out copies of "A Volcano Adventure Seen Through the Eyes of Scientist and Fearless Traveler, Dr. Rosaly Lopes"reader to each student.
- Select students to  re-read ""A Volcano Adventure Seen Through the Eyes of Scientist and Fearless Traveler, Dr. Rosaly Lopes"aloud to the rest of the class.
- Review the Science Word Wall Chart and ask students to refer to their notebooks to help define the words and add new ones.
- Discuss Dr. Lopes' work. (Refer to her biography in Activity 1 of this lesson and the Content Blasts in Activity 2 of this lesson.)
- Direct students to write about what they think is the most amazing thing about volcanoes.
- Also, direct students to write one thing they learned about volcanoes here on Earth and volcanoes found in other places in our solar system.
- Encourage them to draw pictures.

## Science Notebooks

### Let's Begin Our Notebook Activity

Science notebooks are important to being a good scientist, because they help you remember what you see and observe, and what you want to know. As you learn new things, you can add them to your notebook.

Direct students to go back to the first page of their notebooks:

- What did you think about when you imagined standing next to an erupting volcano?
- What did you notice about the mysterious rock, and the volcano model erupting in your classroom?
- What is the difference between magma and lava? Are there cold and hot volcanoes?

Then direct students to go to the last page of their notebooks:

- What do you know about Dr. Lopes and her work studying volcanoes?
- What are some new things you have learned about volcanoes?
- What are some of the physical properties of volcanoes?
- What are some things you have learned about volcanoes here on Earth compared to volcanoes on other planets and moons in our solar system?

## Teacher Post-Assessment Evaluation

Concepts taught in this lesson can be used to create rubrics for evaluating student writing and comprehension through their notebooks.

Use the student writing and discussion to assess the extent to which they accurately observed and understood key concepts about moons through the eyes of Scientist–Fearless Traveler, Dr. Rosaly Lopes.

**Key Concepts**

- Volcanoes are found on Earth and on other planets.
- Volcanoes can be formed by magma, heated material (sulfur), or heated water.
- Volcanoes are areas where heated material from the interior of a body rises to the surface. Different explanations exist about how volcanoes are formed.
- Magma is the molten material beneath Earth's crust, and lava is the molten rock that comes out of a volcano or from a fissure in Earth's surface.
- A fissure is a crack.
- Molten rock comes from the underground magma. Lava is magma that has broken through Earth's surface.
- Rocks form when the heated material from magma cools on the surface.
- Cryovolcanoes are cold volcanoes found on distant moons in the solar system.

# "WHAT SCIENTISTS DO" CHART

## What do I do that is like Dr. Rosaly Lopes?

| Predictions About What Scientists Do | What Scientists Do | How We Were Like Scientists |
|---|---|---|
| Find answers | Often work in groups | Worked in groups |
| Work in labs | Ask questions | Collected data, wrote in notebooks |
| Invent things | Read other scientists' work | Used evidence to discuss what we saw |
| Mix things together | When they disagree, they look for more evidence | Discussed observations and read books by other scientists |